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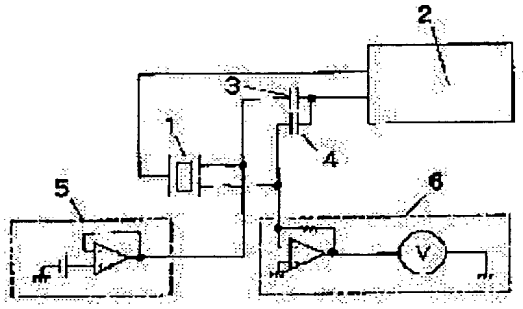
(71)Applicant : SEIKO INSTR INC
(72)Inventor : MURAMATSU HIROSHI
ATAKA TATSUAKI

(54) QUARTZ OSCILLATOR FOR CHEMICAL MEASUREMENT AND CHEMICAL MEASURING EQUIPMENT

(57)Abstract:
PURPOSE: To provide a quartz oscillator and a measuring equipment for measuring a plurality of physical phenomena simultaneously using a quartz oscillator as a detector.
CONSTITUTION: A signal line on the signal output side of a piezoelectric characteristics measuring circuit 2 is connected through capacitors 3, 4 with an electrode of a quartz oscillator 1 for detecting element split at least into two parts. A signal line on the input side of the circuit 2 is connected with an opposing electrode and then the resonance characteristics of the quartz oscillator 1 are measured. At the same time, a voltage is applied between two electrodes and the current flowing between the electrodes is measured thus measuring physical and chemical variations of an object simultaneously.



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CLAIMS

[Claim(s)]
[Claim 1] The quartz resonator characterized by having the electrode which is the quartz resonator used as a sensing element of physicochemical change of the detected matter, touched the detected matter, and was divided or more into at least two.
[Claim 2] The quartz resonator for chemistry measurement according to claim 1 which an electrode calyx is carried out, is the configuration of a mold, and has two electrodes in the electrode into which the above was divided by which the electrode of a pectinate is arranged by turns.
[Claim 3] By connecting the signal line of a signal output side to the electrode into which the above of the quartz resonator for chemistry measurement according to claim 1 was divided through a capacitor, respectively in parallel, and connecting the signal line of a signal input side to the electrode which counters The chemistry metering device characterized by consisting of a piezo-electric property measurement means to measure the resonance characteristic of a quartz resonator, a voltage impression means to impress voltage to inter-electrode [by which the above was divided / two], and an amperometry means to measure the current which flows to inter-electrode at this time, and measuring a physicochemical change of the detected matter.
[Claim 4] By connecting the signal line of a signal output side to the electrode into which the above of the quartz resonator for chemistry measurement according to claim 1 was divided through a capacitor, respectively in parallel, and connecting the signal line of a signal input side to the electrode which counters In order for a piezo-electric property measurement means to measure the resonance characteristic of a quartz resonator, and the electrode into which the above was divided to touch a solution and to make it operate as an operation pole of an electrochemistry measuring circuit, A means to impress voltage to a counter electrode in order to control the potential of the operation pole to a reference pole, A current-potential measurement means to measure the current which the 1st electrode is grounded among the electrodes into which the above was divided, and flows as an operation pole, The chemistry metering device characterized by consisting of a voltage impression means to impress fixed voltage to the 2nd electrode to the 1st electrode of the above among the electrodes by which division was carried out [aforementioned], and an amperometry means to measure the current which flows to the 2nd electrode of the above, and measuring a physicochemical change of the detected matter.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the quartz resonator and chemistry metering device which are used for the measurement in food, medicine, and a chemical-industry field at chemistry, physical chemistry, and a biochemistry row.
[0002]
[Description of the Prior Art] There is a simultaneous metering device of the resonance frequency change of a quartz resonator and resonant-resistance change as chemistry mensuration using a quartz resonator etc. This equipment is effective as a means to measure adsorption and desorption and viscoelasticity change of the matter on the front face of a quartz resonator, and simultaneous measurement with the current potential change accompanying electrochemical reaction is also possible for it by combining with an electrochemistry metering device. On the other hand, it is known that the electrochemical tools of analysis using a comb type electrode are effective as the fixed quantity technique of measurement of the electric conductivity property of a thin film or low-concentration electrochemistry active species.
[0003]
[Problem(s) to be Solved by the Invention] It is not easy to consider the correspondence relation of these results, in order to measure separately, respectively, although various kinds of measurement technique is used and the measurement result for every measurement technique is generally obtained to the detected matter, and since it will be necessary to carry out by repeating a measurement action, it is inefficient.
[0004] The electrochemistry mensuration using the quartz resonator and the comb type electrode measures the property of the electrode which covered the thin film, respectively, or has the feature of being able to use as a sensing element of liquid chromatography. Then, by using these two measurement technique simultaneously, the purpose of this invention is one-time measurement, and is realizing the highly efficient detection equipment with which two or more information's is acquired.
[0005]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, in this invention, the electrode which touches the detected matter among the electrodes of the quartz resonator for sensing elements was divided or more into two, the electrode was made into the comb type configuration, and it considered as the quartz resonator which arranges the electrode of a pectinate by turns. As a measuring device, as equipment which measures only electric conductivity, connect the signal line of a signal output side to the divided electrode through a capacitor, respectively in parallel, and moreover, by connecting the signal line of a signal input side to the electrode which counters It consisted of a piezo-electric property measurement means to measure the resonance characteristic of a quartz resonator, a voltage impression means to impress voltage to inter-electrode [which was divided / two], and an amperometry means to measure the current which flows to inter-electrode at this time, and considered as the equipment which measures a physicochemical change of the detected matter.
[0006] Furthermore, by connecting the signal line of a signal output side to the divided electrode through a capacitor as equipment for electrochemical measurement, respectively in parallel, and connecting the signal line of a signal input side to the electrode which counters A piezo-electric property measurement means to measure the resonance characteristic of a quartz resonator, and in order for the divided electrode to touch a solution and to make it operate as an operation pole of an electrochemistry measuring circuit, A means to impress voltage to a counter electrode in order to control the potential of the operation pole to a reference pole, A current-potential measurement means to measure the current which the 1st electrode is grounded among the divided electrodes and flows as an operation pole, It consisted of a voltage impression

means to impress fixed voltage to the 2nd electrode to the 1st electrode among the divided electrodes, and an amperometry means to measure the current which flows to the 2nd electrode, and considered as the equipment which measures a physicochemical change of the detected matter.
[0007]
[Function] Measurement of the resonance characteristic of a quartz resonator with the divided electrode became possible by connecting the signal line of the signal output side of a piezo-electric property measurement means through a capacitor, respectively in parallel, and connecting the signal line of the input side of a piezo-electric property measurement means to the electrode which counters. It is effective in separating the signal of the dc component in the RF signal of a piezo-electric property measurement means, electric conductivity, and electrochemistry measurement to use this capacitor.
[0008] It is possible to detect the viscosity of the liquid which there are resonance frequency change and resonant-resistance change, and the weight change accompanying the adsorption and desorption of the matter to a quartz-resonator front face or a covering film is mainly obtained from resonance frequency change as a property of a quartz resonator, and touches a quartz-resonator front face from resonant-resistance change, or a covering film, and viscoelasticity change. Moreover, measurement of a current potential curve is possible simultaneously combining electric conductivity or electrochemistry system of measurement by the comb type electrode.
[0009]
[Example] Hereafter, the example of this invention is explained based on a drawing.
(Composition of the quartz resonator for chemistry measurement) Drawing 1 (A) and (B) are the ** type views of the quartz resonator 101 which divided the electrode 102 by the side of a front face into two, and allotted the counterelectrode 104 to the rear-face side. The quartz resonator mainly used in the example is 9MHz in fundamental frequency, it is 8mm angle of every direction, and a thing with a thickness of about 0.18mm, and an electrode makes gold form on a chromium ground with vacuum deposition. The electrode of the front face which touches the detected matter is **********ing a center section 103 using photo lithography technology, and divided the electrode into two. The electric contact to a measuring device was taken from the portion prolonged at the end of the quartz-resonator board of an electrode.
[0010] Drawing 2 (A) and (B) are the ** type views of the quartz resonator 101 which used the division electrode 105 by the side of a front face as the comb type electrode, and allotted the counterelectrode 104 to the rear-face side. In a standard experiment, although the width of face of a comb type electrode and inter-electrode width of face were manufactured as 15 micrometers, respectively, they can narrow width of face to about 2 micrometers in fact.
[0011] Moreover, it is also possible to divide further the electrode by the side of a front face, and to constitute the reference electrode for electrochemistry measurement on a quartz resonator.
(Equipment for simultaneous measurement of electric conductivity) Drawing 3 shows the ** type view of the measuring device for electric conductivity measurement. In drawing 3 , the signal line of the signal output side of the piezo-electric property measuring circuit 2 can measure the resonance characteristic of a quartz resonator now by connecting with the electrode divided through capacitors 3 and 4, respectively in parallel, and connecting the signal line of the input side of the piezo-electric property measuring circuit 2 to the electrode which counters. The voltage impression circuit 5 is simultaneously connected to one side of two electrodes by which the above was divided, and the circuit 6 for amperometries is connected to another [which is grounded electrically] electrode. By measuring this current, the electric conductivity on the front face of an electrode can be measured.
[0012] (Equipment for electrochemistry simultaneous measurement) Drawing 4 shows the ** type view of the measuring device for electrochemistry measurement. In drawing 4 , the signal line of the signal output side of the piezo-electric property measuring circuit 2 can measure the resonance characteristic of a quartz resonator now by connecting with the electrode divided through capacitors 3 and 4, respectively in parallel, and connecting the signal line of the input side of the piezo-electric property measuring circuit 2 to the electrode which counters. The electrode which touches the quality of a device under test of a quartz resonator 1 is dedicated to an electrode holder so that only an electrode may be exposed into the electrolysis cell 7 for electrochemistry measurement as an operation pole, and it is held with the reference electrode 8 and the counter electrode 9. The potentiostat circuit 10 which impresses voltage to a counter electrode 9 so that arbitrary potentials can be set as an operation pole is connected to each electrode to the potential of the reference pole 8. While one side of an electrode by which the quartz resonator was divided is grounded electrically, the circuit 11 which measures the current which flows as an operation pole is connected. Potential can be arbitrarily set to another electrode and the circuit 12 which measures the current which flows as 2nd operation pole is connected to it.

[0013] (Property measuring circuit of a quartz resonator) As a piezo-electric property measuring circuit 2, an oscillator circuit or impedance measurement equipment is usable. Commercial impedance measurement equipment shows the example in the case of using an oscillator circuit to drawing 5 , although it is connectable as it is. In drawing 5 , the electrode of the side which the detected matter of a quartz resonator does not touch is connected to the input side of NAND13 by which the capacitor 15 is connected in parallel with resistance 14 while an input terminal connects too hastily, and the output side of NAND13 is connected to one terminal of a capacitor 16. two capacitors 3 and 4 to which he is connected to the input side of NAND17 to which resistance 18 is connected in parallel while an input terminal short-circuits the other-end child of a capacitor 16, and the output side of NAND17 is connected in parallel with the electrode of the divided quartz resonator -- it is alike, respectively and connects As shown in drawing 6 also in the method using this oscillator circuit, simultaneously with resonance frequency change, measurement of a resonant resistance is also possible by adding the alternating-voltage measuring circuit 19 for measuring the amplitude of the signal of the input side of an oscillator circuit in addition to the circuit shown by drawing 5 . This has the fixed amplitude of the signal impressed to a quartz resonator, and is for the amplitude of the input point of an oscillator circuit to change with the ratios of the impedance of a quartz resonator, and the input impedance of an oscillator circuit.

[0014] (Application to a gas sensor) Based on the measuring device shown by drawing 3 , the lipid membrane was covered on the quartz resonator and it applied to the gas sensor. Resonance frequency change produced the lipid membrane also by humidity while resonance frequency change occurred by volatile organic gas, such as ethanol. On the other hand, by the measurement result of electric conductivity, it became clear by organic gas that the change corresponding to humidity is shown to humidity to being almost changeless. That is, this equipment is one sensor and it became clear that it is the measuring device which distinguishes change of organic gas and humidity simultaneously and can measure it.

(Application to a liquid chromatography detector) It measured by equipping a flow cell with a quartz resonator so that the electrode into which the quartz resonator was divided might touch sample liquid based on the measuring device shown by drawing 3 . While being able to measure a viscous change of the sample solution by measuring resonance frequency change or resonant-resistance change of a quartz resonator, the conductivity of a liquid was able to be simultaneously measured by the current which flows to comb type inter-electrode.

[0015] (Application to electrochemistry measurement) Based on the measuring device shown by drawing 4 , the electrolytic deposition of the polypyrrole film was carried out in a pyrrole and sodium-perchlorate solution on the electrode into which the quartz resonator was divided. When potential was electrochemically scanned in the electrolytic solution using the quartz resonator fully covered with the polypyrrole film, the resonant-resistance change reflecting the resonance frequency change accompanying movement of the ion to the inside of a polypyrrole film and viscoelasticity change produced by membranous oxidation reduction and change of the conductivity produced by the membranous oxidation reduction state and doping of ion have measured with the current potential curve. It was shown that it is clear this method's for it to be able to apply to various kinds of macromolecule covered electrodes, such as the poly aniline, and it is effective as research equipment for electrochemistry.

[0016] The thing of a quartz resonator of the fundamental frequency from 1MHz to 40MHz is above usable at a AT cut and BT cut.

[0017]

[Effect of the Invention] With the quartz resonator for chemistry measurement and equipment of this invention, the sensor system which can detect two or more items simultaneously newly could be built, and the technique of still newer electrochemistry research was able to be offered.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the ** type view of the quartz resonator for chemistry measurement of this invention.
[Drawing 2] It is the ** type view of the quartz resonator for chemistry measurement of this invention.
[Drawing 3] It is the ** type view of the equipment for chemistry measurement of this invention.
[Drawing 4] It is the ** type view of the equipment for chemistry measurement of this invention.
[Drawing 5] It is the ** type view of an oscillator circuit usable to this invention.
[Drawing 6] It is the ** type view of an oscillator circuit usable to this invention.
[Description of Notations]
1 Quartz Resonator
2 Piezo-electric Property Measuring Circuit
3, 4, 15, 16 Capacitor
5 Voltage Impression Circuit
6 11 Circuit for amperometries
7 Electrolysis Cell
8 Reference Electrode
9 Counter Electrode
10 Potentiostat Circuit
12 Potential Setup and Amperometry Circuit
13,17 NAND
14 18 Resistance
19 Alternating-Voltage Measuring Circuit

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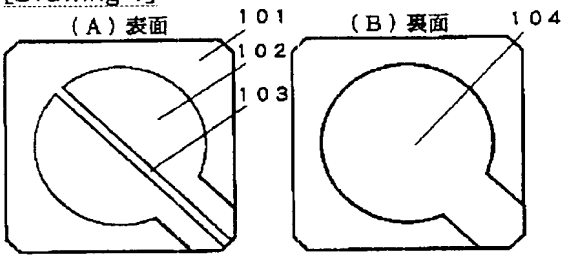
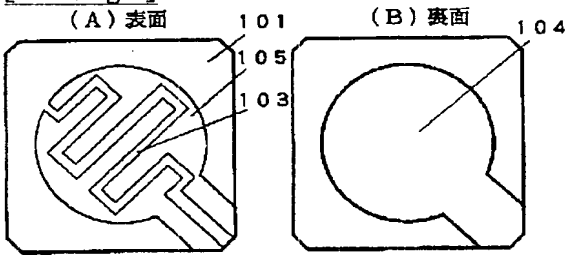
DRAWINGS

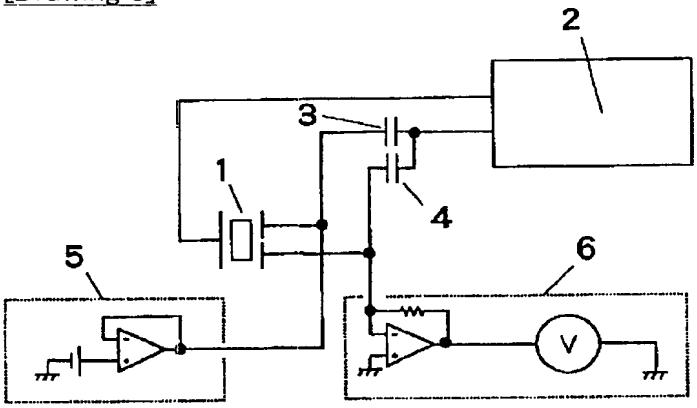
[Drawing 1]



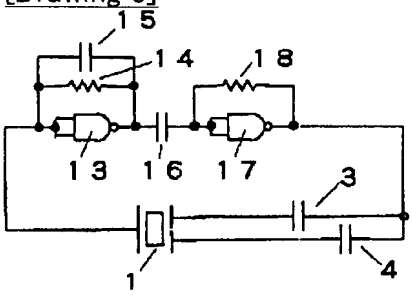
[Drawing 2]



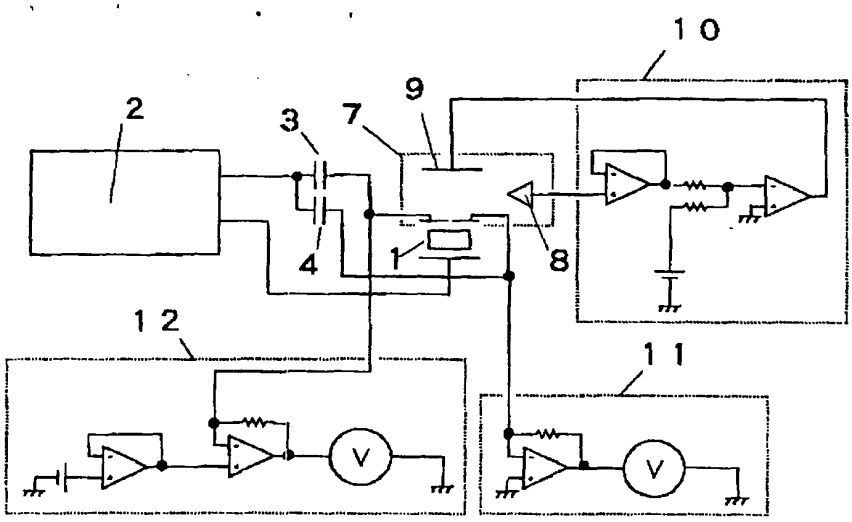
[Drawing 3]



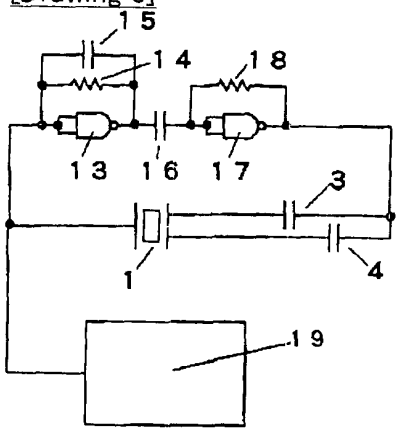
[Drawing 5]



[Drawing 4]



[Drawing 6]



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審査請求　未請求　請求項の数４　ＯＬ　（全　５　頁）

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(71)出願人　000002325
セイコー電子工業株式会社
東京都江東区亀戸６丁目31番１号

(72)発明者　村松　宏
東京都江東区亀戸６丁目31番１号　セイコー電子工業株式会社内

(72)発明者　安宅　龍明
東京都江東区亀戸６丁目31番１号　セイコー電子工業株式会社内

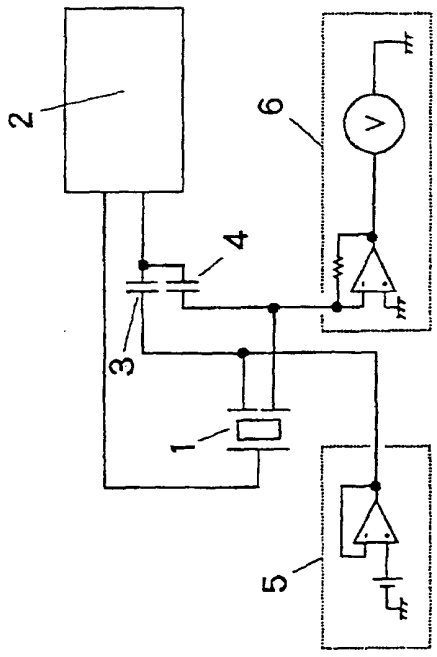
(74)代理人　弁理士　林　敬之助

(54)【発明の名称】　化学計測用水晶振動子及び化学計測装置

(57)【要約】

【目的】　水晶振動子を検出器とする測定法において、複数の物理現象を同時に計測する、水晶振動子および計測装置を提供する。

【構成】　検出素子用水晶振動子の電極において、被検出物質に接する電極が少なくとも２つ以上に分割されている水晶振動子を用いて、この水晶振動子の分割された電極に圧電特性測定回路の信号出力側の信号線を並列にコンデンサーを介して接続し、対向する電極に前記の圧電特性測定回路の入力側の信号線を接続することによって、水晶振動子の共振特性を測定するとともに、同時に、前記の分割された２つの電極間に電圧を印加し、このとき電極間に流れる電流を測定することによって、被検出物の物理化学的な変化を同時に測定する。



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【特許請求の範囲】

【請求項１】　被検出物質の物理化学的変化の検出素子として用いられる水晶振動子であって、被検出物質に接し、少なくとも２つ以上に分割された電極を有することを特徴とする水晶振動子。

【請求項２】　前記の分割された電極のうちの２つの電極がくし型の形状であり、くし状の電極が交互に配置されている電極を有する請求項１記載の化学計測用水晶振動子。

【請求項３】　請求項１記載の化学計測用水晶振動子の前記の分割された電極に信号出力側の信号線を並列にそれぞれコンデンサーを介して接続し、対向する電極に信号入力側の信号線を接続することによって、水晶振動子の共振特性を測定する圧電特性測定手段と、前記の分割された２つの電極間に電圧を印加する電圧印加手段と、このとき電極間に流れる電流を測定する電流測定手段から構成され、被検出物質の物理化学的な変化を測定することを特徴とする化学計測装置。

【請求項４】　請求項１記載の化学計測用水晶振動子の前記の分割された電極に信号出力側の信号線を並列にそれぞれコンデンサーを介して接続し、対向する電極に信号入力側の信号線を接続することによって、水晶振動子の共振特性を測定する圧電特性測定手段と、前記の分割された電極が溶液に接し、電気化学測定回路の作用極として動作させるため、参照極に対する作用極の電位を制御するために対極に電圧を印加する手段と、前記の分割された電極のうち第１の電極が接地され作用極として流れる電流を測定する電流電圧測定手段と、前記分割された電極のうち第２の電極に前記第１の電極に対して一定電圧を印加する電圧印加手段と、前記第２の電極に流れる電流を測定する電流測定手段から構成され、被検出物質の物理化学的な変化を測定することを特徴とする化学計測装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、化学、物理化学、生化学ならびに食品、医療、化学工業分野における計測に利用される水晶振動子および化学計測装置に関する。

【０００２】

【従来の技術】水晶振動子を用いる化学計測法としては、水晶振動子の共振周波数変化と共振抵抗変化の同時計測装置などがある。この装置は、水晶振動子表面への物質の吸脱着や粘弾性変化を測定する手段として有効であり、電気化学計測装置と組み合わせることによって、電気化学反応にともなう電流電位変化との同時計測も可能である。一方、くし型電極を用いる電気化学的な分析手法は、薄膜の電導度特性の測定や低濃度の電気化学活性種の定量手法として有効であることが知られている。

【０００３】

【発明が解決しようとする課題】一般に、被検出物質に

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対して、各種の計測手法が用いられ、各計測手法ごとの測定結果が得られるが、それぞれ別個に測定を行うために、これらの結果の対応関係を考察することは、容易ではなく、測定行為も繰り返し行う必要が生じるため非効率である。

【０００４】水晶振動子およびくし型電極を用いた電気化学計測法は、それぞれ、薄膜を被覆した電極の特性を測定したり、液体クロマトグラフィーの検出素子として利用できるなどの特徴がある。そこで本発明の目的は、この２つの計測手法を同時に用いることによって、一度の測定で、複数の情報が得られる高機能な検出装置を実現することである。

【０００５】

【課題を解決するための手段】上記課題を解決するために、本発明では、検出素子用水晶振動子の電極のうち、被検出物質に接する電極を２つ以上に分割し、その電極をくし型の形状とし、くし状の電極を交互に配置する水晶振動子とした。また、測定装置としては、電導度のみを測る装置として、分割された電極に信号出力側の信号線を並列にそれぞれコンデンサーを介して接続し、対向する電極に信号入力側の信号線を接続することによって、水晶振動子の共振特性を測定する圧電特性測定手段と、分割された２つの電極間に電圧を印加する電圧印加手段と、このとき電極間に流れる電流を測定する電流測定手段から構成され、被検出物質の物理化学的な変化を測定する装置とした。

【０００６】さらに、電気化学的な測定を対象とする装置として、分割された電極に信号出力側の信号線を並列にそれぞれコンデンサーを介して接続し、対向する電極に信号入力側の信号線を接続することによって、水晶振動子の共振特性を測定する圧電特性測定手段と、分割された電極が溶液に接し、電気化学測定回路の作用極として動作させるため、参照極に対する作用極の電位を制御するために対極に電圧を印加する手段と、分割された電極のうち第１の電極が接地され作用極として流れる電流を測定する電流電圧測定手段と、分割された電極のうち第２の電極に第１の電極に対して一定電圧を印加する電圧印加手段と、第２の電極に流れる電流を測定する電流測定手段から構成され、被検出物質の物理化学的な変化を測定する装置とした。

【０００７】

【作用】分割された電極を持つ水晶振動子の共振特性の測定は、圧電特性測定手段の信号出力側の信号線を並列にそれぞれコンデンサーを介して接続し、対向する電極に圧電特性測定手段の入力側の信号線を接続することによって可能となった。このコンデンサーを用いることは、圧電特性測定手段の高周波信号と電導度および電気化学測定における直流成分の信号を分離する効果がある。

【０００８】水晶振動子の特性としては、共振周波数変

化と共振抵抗変化があり、共振周波数変化からは主に、水晶振動子表面や被覆膜への物質の吸脱着に伴う重量変化が得られ、共振抵抗変化からは、水晶振動子表面に接する液体や被覆膜の粘性や粘弾性変化を検出することが可能である。また同時に、くし型電極によって電導度や電気化学測定系を組み合わせて電流電位曲線の測定が可能である。

【０００９】

【実施例】以下、この発明の実施例を図面に基づいて説明する。

（化学計測用水晶振動子の構成）図１（Ａ），（Ｂ）は、表面側の電極１０２を２つに分割し、裏面側に対向電極１０４を配した水晶振動子１０１の模式図である。実施例で主に用いた水晶振動子は、基本周波数９ＭＨｚで、縦横８ｍｍ角、厚さ約０．１８ｍｍのもので、電極は真空蒸着によって、クロム下地の上に金を形成させたものである。被検出物質に接する表面の電極は、フォトリソグラフィー技術を用いて中央部１０３をエッチングすることで、電極を２つに分離した。測定装置への電気的な接点は、電極の水晶振動子板の端に延びた部分からとった。

【００１０】図２（Ａ），（Ｂ）は、表面側の分割電極１０５をくし型電極とし、裏面側に対向電極１０４を配した水晶振動子１０１の模式図である。標準的な実験では、くし型の電極の幅と電極間の幅は、それぞれ１５μｍとして製作したが、実際には、２μｍ程度まで、幅を狭めることができる。

【００１１】また、表面側の電極をさらに分割して電気化学測定用の参照電極を水晶振動子上に構成することも可能である。

（電導度の同時測定用装置）図３は、電導度測定用の測定装置の模式図を示したものである。図３において、圧電特性測定回路２の信号出力側の信号線は、並列にそれぞれコンデンサー３，４を介して、分割された電極に接続され、対向する電極には、圧電特性測定回路２の入力側の信号線が接続されることによって、水晶振動子の共振特性が測定できるようになっている。同時に、前記の分割された２つの電極の一方には、電圧印加回路５が接続され、電気的に接地されているもう一方の電極には、電流測定用回路６が接続されている。この電流を測定することで、電極表面の電導度を測定できる。

【００１２】（電気化学同時測定用装置）図４は、電気化学測定用の測定装置の模式図を示したものである。図４において、圧電特性測定回路２の信号出力側の信号線は、並列にそれぞれコンデンサー３，４を介して、分割された電極に接続され、対向する電極には、圧電特性測定回路２の入力側の信号線が接続されることによって、水晶振動子の共振特性が測定できるようになっている。水晶振動子１の被測定物質に接する電極は、作用極として電気化学測定用電解セル７の中に電極のみが露出するようにホルダーに納められ、参照電極８、対極９とともに保持されている。各電極には、参照極８の電位に対して、作用極に任意の電位を設定できるよう電圧を対極９に印加するポテンショスタット回路１０が、接続されている。水晶振動子の分割された電極の一方は、電気的に接地されるとともに、作用極として流れる電流を測定する回路１１が接続されている。もう一方の電極には、電位を任意に設定でき、第２の作用極として流れる電流を測定する回路１２が接続されている。

【００１３】（水晶振動子の特性測定回路）圧電特性測定回路２としては、発振回路あるいはインピーダンス測定装置が使用可能である。市販のインピーダンス測定装置は、そのまま接続が可能であるが、発振回路を使用する場合の例を図５に示す。図５では、水晶振動子の被検出物質の接しない側の電極が、入力端子が短絡されるとともに並列に抵抗１４とコンデンサー１５が接続されているＮＡＮＤ１３の入力側に接続され、ＮＡＮＤ１３の出力側が、コンデンサー１６の一方の端子に接続されている。コンデンサー１６の他方の端子は、入力端子が短絡されるとともに並列に抵抗１８が接続されているＮＡＮＤ１７の入力側に接続され、ＮＡＮＤ１７の出力側が、分割された水晶振動子の電極に並列に接続されている２つのコンデンサー３，４それぞれに接続されている。この発振回路を用いる方法の場合も、図６に示すように、図５で示した回路に加えて、発振回路の入力側の信号の振幅を測定するための交流電圧測定回路１９を付加することによって、共振周波数変化と同時に共振抵抗の測定も可能である。これは、水晶振動子に印加される信号の振幅が一定であり、水晶振動子のインピーダンスと発振回路の入力インピーダンスの比によって、発振回路の入力点の振幅が変化するためである。

【００１４】（ガスセンサーへの応用）図３で示した測定装置をもとに、水晶振動子上に脂質膜を被覆して、ガスセンサーに適用した。脂質膜は、エタノールなどの揮発性有機ガスによって、共振周波数変化が起きるとともに、湿度変化によっても共振周波数変化が生じた。一方、電導度の測定結果では、有機ガスでは、ほとんど変化がないのに対して、湿度変化に対しては、湿度に対応した変化を示すことが明らかになった。すなわち、この装置は、一つのセンサーで、有機ガスと湿度の変化を同時に区別して測定できる測定装置であることが明らかになった。

（液体クロマトグラフィー検出器への応用）図３で示した測定装置をもとに、水晶振動子の分割された電極が被検液に接するように、水晶振動子をフローセルに装着して、測定を行った。水晶振動子の共振周波数変化あるいは共振抵抗変化を測定することによって、試料溶液の粘性変化を測定できるとともに、くし型電極間に流れる電流によって、液体の導電率を同時に測定することができた。

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【００１５】（電気化学測定への応用）図４で示した測定装置をもとに、ピロール、過塩素酸ナトリウム水溶液中で、水晶振動子の分割された電極上にポリピロール膜を電解析出させた。十分にポリピロール膜で被覆された水晶振動子を用いて、電解質溶液中で電気化学的に電位の走査を行ったところ、ポリピロール膜中へのイオンの移動にともなう共振周波数変化、膜の酸化還元によって生じる粘弾性変化を反映する共振抵抗変化、膜の酸化還元状態とイオンのドーピングによって生じる導電率の変化が、電流電位曲線とともに測定できた。この方法は、ポリアニリンなど各種の高分子被覆電極に適用可能であることが明らかで、電気化学用の研究装置として有効であることが示された。

【００１６】以上において、水晶振動子は、ＡＴカットおよびＢＴカットで、１ＭＨｚから４０ＭＨｚまでの基本周波数のものが使用可能である。

【００１７】

【発明の効果】本発明の化学計測用水晶振動子及び装置によって、新規に複数の項目の検出が同時に行える、センサーシステムを構築することができ、さらに、新しい電気化学研究の手法を提供することができた。

【図面の簡単な説明】

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＊【図１】本発明の化学計測用水晶振動子の模式図である。

【図２】本発明の化学計測用水晶振動子の模式図である。

【図３】本発明の化学計測用装置の模式図である。

【図４】本発明の化学計測用装置の模式図である。

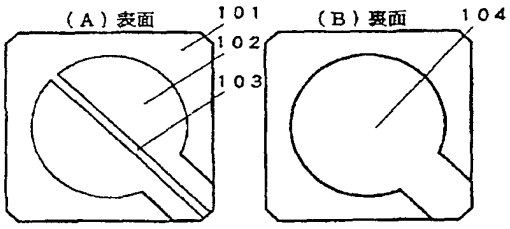
【図５】本発明に使用可能な発振回路の模式図である。

【図６】本発明に使用可能な発振回路の模式図である。

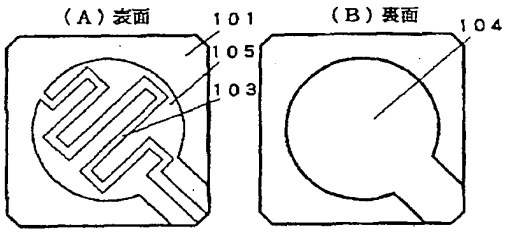
【符号の説明】

１　水晶振動子
２　圧電特性測定回路
３，４，１５，１６　コンデンサー
５　電圧印加回路
６，１１　電流測定用回路
７　電解セル
８　参照電極
９　対極
１０　ポテンショスタット回路
１２　電位設定および電流測定回路
１３，１７　ＮＡＮＤ
１４，１８　抵抗
１９　交流電圧測定回路

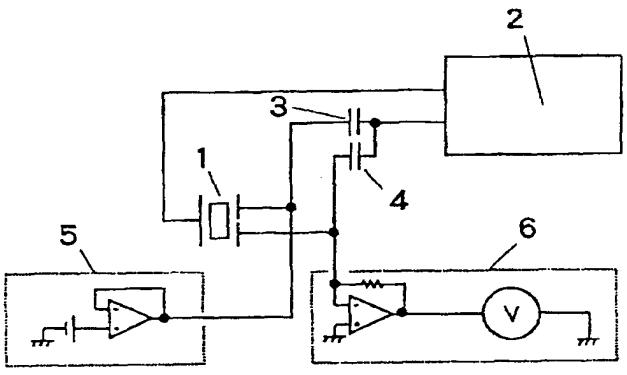
【図１】



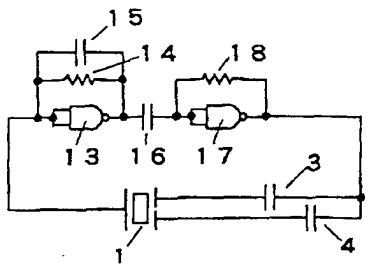
【図２】



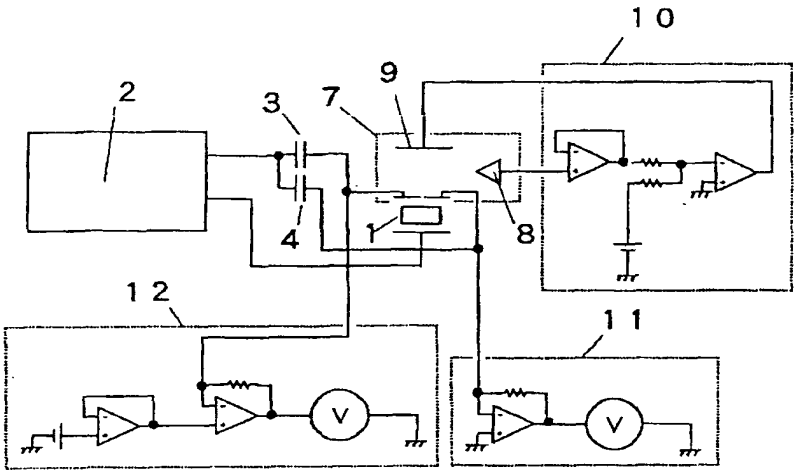
【図３】



【図５】



【図４】



【図６】